



Atlanta households' willingness to increase urban forests to mitigate climate change



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ABSTRACT

Investments in urban forests have been increasing in many US cities. Urban forests have been shown to provide countless ecosystem benefits with many addressing climate change issues, such as sequestering carbon, reducing air pollution, and decreasing the heat island effect. Individual groups within the American public may not respond to the issue of climate change in the same way, thus engaging each group in climate change solutions will require different approaches. It is therefore important to understand how the public perceives climate change, their values and preferences, and barriers that might constrain their engagement to policy solutions. A mail survey was implemented, focused on households' willingness to support and pay for urban forests as a climate change mitigation method. Atlanta, Georgia, USA was selected for this study given its environmental issues such as heat island effect and land cover changes, including conversion of forestland, that come with rapid population growth and urban sprawl. A Tobit model was used to model willingness-to-pay as a function of several variables derived from survey results; and a multivariate weighting strategy was used to address nonresponse issues. The analysis showed that Atlanta households are willing to pay \$1.05 million to \$1.22 million per year, or \$5.24 to \$6.11 million over a five-year period. The WTP amount was significantly related with the residents' income, media source from where they received climate information, and the relative coverage of tree canopy around their residence. Results are relevant to city managers who are interested in understanding the public value of urban greening programs and developing strategies or policies to expand urban forests as part of a climate change strategy.

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1. Introduction

Urban areas have the highest concentration of population, industries, and infrastructure. They are also likely to face several impacts of climate change such as heat waves (UN Habitat, 2011). For instance, the concentration of population in urban areas could mean a bigger proportion of human population could be vulnerable to climate-related risks. According to the US Census, 80 percent of the US population resides in urban areas, which are defined as areas with at least 50,000 people residing in Census-designated urban areas (US Census Bureau, 2011). Because of increased urbanization and land fragmentation, policymakers have increasingly looked at ways to improve the sustainability and livability of cities while

addressing climate change mitigation and adaptation. One method has been to increase investments in urban forests. In fact, some urban forest management plans refer directly to climate change considerations (Atlantaga.gov., 2012; Seattle.gov., 2013).

Investments in urban forests have been increasing in many US cities and studies emphasize that any increase in urban forests is desirable and will mitigate pollution problems (McPherson et al., 2013; Roy et al., 2012; Manning, 2008). Urban forests have been known to provide ecosystem benefits that address both climate change mitigation and adaptation issues, such as sequestering carbon, reducing air pollution, and decreasing the heat island effect (Walton et al., 2016; Thomas and Geller, 2013; UN Habitat, 2011). It is estimated that urban forests capture 23 million tons of carbon every year (Nowak and Crane, 2002), which is the equivalent annual emissions of 4.9 million cars (US Environmental Protection Agency, 2016).

Despite the high awareness of climate change among the American public due to news media coverage (Leiserowitz et al., 2013)

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and the known benefits of urban forests, this awareness may not translate into a willingness to pay for climate change benefits from urban forests. In addition, subgroups within the American public may not respond to the issue of climate change in the same way. Engaging each group to participate in climate change solutions will require different approaches. Therefore, it is important to understand how the public perceives climate change, as well as their values and preferences, and barriers that might constrain their engagement in policy processes. Some essential questions that must be addressed first are: 1) are urban forests a preferred climate change mitigation and adaptation method; 2) will people support such proposed urban forest policies; and 3) are they willing to pay to increase investments in them. To address these questions, a mail survey of urban residents was implemented. Few studies have explored the nature and origins of support for different types of mitigation policies. One study found that Norwegians favored policy options that are good for the environment, but present low personal hardship, such as tree-planting rather than measures that require difficult tradeoffs, such as limiting population growth and a carbon tax (Rosentrater et al., 2013). This study is distinguished from other climate change studies (Lachapelle et al., 2012; Lee and Cameron, 2008) in that the focus was on households' willingness to support and pay for urban forests as a climate change mitigation method. Atlanta, Georgia, USA was selected for this study given its environmental issues such as heat island effect and land cover changes, including conversion of forestland, that come with rapid population growth and urban sprawl (Stone et al., 2013).

2. Background

People tend to choose to live in and cluster around urban areas, but because of the concentrated nature of their pollution and increased consumption of resources, urban areas tend to heavily contribute to environmental problems. It is estimated that more than 75 percent of global carbon emissions come from urban areas (Satterthwaite, 2008). Cities can respond to climate change concerns through emissions mitigation but also by taking or promoting adaptive strategies (UN Habitat, 2011); however, Stone (2012) suggested that rather than focusing purely on emission reductions, adaptive strategies such as innovative land use planning, should also be employed. According to previous research, the most effective ways to adapt to rising heat effect of climate change could be planting trees and expanding natural vegetation in urban areas (Zhou and Shepherd, 2010; Stone et al., 2013).

In urban areas, afforestation projects are increasingly common. These projects are intended to capture carbon as well as improve air quality, lower air temperatures during hot weather months, increase stormwater infiltration, and create wildlife habitat (Oldfield et al., 2014). Urban forests provide many benefits, including improved air quality (Nowak et al., 2006), shade from leaf foliage during the growing season months (Akbari, 2002), increased real estate values (Payton et al., 2008), stormwater regulation (Inkilainen et al., 2013), health benefits (Lee and Maheswaran, 2011), and the mitigation of the heat island effect (Lynn et al., 2009). Stone (2012) found that the heat island effect can cause climate change effects, such as changes in precipitation, clouds, and daily temperature ranges in localized areas or regions.

Some studies have estimated the monetary value of nonmarket benefits derived from urban forests. Majumdar et al. (2011) examined the aesthetic value of urban forests for tourists in Savannah, Georgia. Lorenzo et al. (2000) estimated residents' willingness-to-pay (WTP) for community urban forests in Mandeville, Louisiana. Treiman and Gartner (2006) studied residents in Missouri communities and estimated their WTP for establishing a tree fund for community forests. These studies examined how much residents

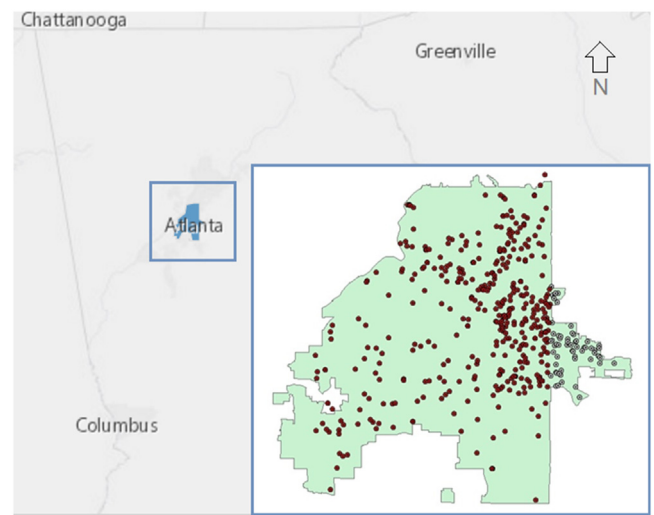


Fig. 1. Study Area, Municipal Boundary Line, and Survey Respondents of Atlanta, Georgia (Dark plots indicate respondents in Fulton County and light plots indicate respondents in DeKalb County).

were willing to pay for urban forests as a whole and not for specific benefits that the urban forests may provide.

Addressing climate change requires multiple approaches with varying costs. Given the benefits of urban forests to climate change solutions, we attempted to address individuals' willingness to pay for urban forests as one method to address climate change mitigation. We examined what climate change and urban forest attitudes contributed to supporting climate change policy options, what influence media may have on climate change attitudes, and estimates of willingness-to-pay.

3. Methodology

A mail-based survey was developed and administered using Dillman's Tailored Design Method (Dillman et al., 2009). The survey was divided into three sections to gauge: (1) respondents' attitudes towards climate change and the potential of urban forests to address climate change effects; (2) respondents' views of climate change policies and their willingness to pay for expanding urban forests as a method to address climate change mitigation; (3) and respondents' demographics. Survey Sampling International¹ provided randomly selected addresses within the city boundaries of Atlanta (Fig. 1). A pre-test was first implemented on 200 randomly selected addresses in Atlanta. Based on similar studies, a response rate of at least 20 percent was expected (Foster and Tobin, 2013; Lee and Cameron, 2008; Lorenzo et al., 2000). The pre-test yielded a response rate of 10 percent, which led to the decision to focus on increasing the number of responses so that a larger number of observations would be available for analysis. In November 2013, a pre-notification postcard was sent to 5500 Atlanta households. The survey itself was mailed out two weeks later, followed by a reminder postcard three weeks later. As survey responses were received, the percentage of tree canopy for each respondent's corresponding Census tract was estimated by using the i-Tree Canopy² program. Tree canopy percentages for respondents' respective Census tracts ranged from 2.5 percent to 67.6 percent with a standard error of ± 3.0 . Overall tree canopy for Atlanta was calculated, resulting in 36.6 percent tree cover (standard error of ± 0.8), which is

¹ Survey Sampling International, LLC, Shelton, CT, USA. www.surveysampling.com.

² i-Tree Canopy. I-Tree Software Suite v.5.x. (n.d.). Web.

equivalent to about 48.5 square miles of land comprised of urban forests. Survey respondents were provided a scenario of a five percent expansion of urban forests, which would add 2.44 additional square miles or 1,551.6 acres of urban forest cover.

Selection bias can occur if individuals who feel strongly about urban forests are more likely to respond to the survey, which could bias WTP estimates either upward or downward, depending on if the respondent feels strongly positive or negative toward the amenity (Mitchell and Carson, 1989). Related to selection bias is nonresponse bias, which arises when the observable characteristics that influence WTP of respondents differ from those of nonrespondents (Whitehead et al., 1992). Post sample weighting was used to correct for the bias and the weighted data were used in the models discussed later. This method is widely used to address bias from unit nonresponse (Mitchell and Carson, 1989; Peress, 2010; Oberski, 2008; Groves, 2006; Brox et al., 2003). Because post weighting occurs after data collection, the methods employed for this strategy is discussed in the “Data” section of this paper.

The contingent valuation method (CVM) typically involves asking respondents how much they are willing to give up, or pay, in current household income in exchange for an increase in the level of a public good. In such a contingent market, the CVM attempts to measure a household's compensating surplus for a change in the good in question with the basic premise that individuals have preferences for market and nonmarket goods and that they can order the bundles of goods in terms of desirability (Flores, 2003). Assumed is that individuals can choose the amount of each market good based on prices, $P = [p_1, p_2, \dots, p_n]$, and available income. Individuals cannot choose the optimal amount of nonmarket goods and are instead fixed and determined by societal choices (Flores, 2003). The basic choice problem is how a household obtains the highest level of utility, U , while spending income, y , toward the purchase of market goods, $X = [x_1, x_2, \dots, x_n]$, subject to the rationed level of nonmarket goods, $Q = [q_1, q_2, \dots, q_k]$.

$$\max_X U(X, Q) \text{ s.t. } P * X \leq y, Q = Q^0 \quad (1)$$

The survey instrument provided a scenario and asked the respondent if the respondent would vote in favor of an increase in urban forests in Atlanta if the measure were included on the next ballot. Specifically, they were asked how much they were willing to pay for an additional five percent area in urban forests to mitigate climate change per household annually for five years, using a fully open-ended bidding process. That is, respondents were invited to state directly their highest WTP for the offered scenario. Open-ended methods have been found to elicit lower WTP amounts than dichotomous choice (Balistreri et al., 2001) or payment card approaches (Cameron et al., 2002), and therefore, providing more conservative WTP estimates. A five percent increase was selected because this would increase Atlanta's current canopy coverage to just over 50 percent, a number recommended by American Forests (2001) for metro areas with larger suburban settings.

To determine the rationale for the respondents' answers, follow up questions were asked if zero WTP amounts were entered. Choices included (a) cannot afford to pay at this time, (b) do not have enough information to make a comfortable decision, (c) not worth anything to me, (d) do not think this program will work, (e) opposed to new government program, or (f) unfair for me to pay for this program. Respondents who selected (a), (b), or (c) were classified as legitimate zero bidders and (d), (e), or (f) responses were classified as legitimate protest bidders (Yu and Abler, 2010; Cho et al., 2008; Bowker et al., 2003). Protest bidders can be distinguished from zero bidders in that they reject the program because they are opposed to paying for it (Halstead et al., 1992). They may not be different from other responders except that their zero WTP

bid reflects a rejection of the contingent market rather than an indication of their underlying WTP.

The Tobit model was chosen to explain WTP bids. This model predicts continuous WTP data, allowing for a large number of zero observations without causing sample selection bias (Wooldridge, 2010). An ordinary least squares (OLS) model applied to censored data would generate biased and inconsistent estimates (Long, 1997). Several CVM studies treated WTP bids as if they were censored at zero and estimated subsequent bid functions using Tobit estimators (Poudyal et al., 2015; Cho et al., 2005; Bowker et al., 2003). The model is defined as

$$y_i^* = x_i\beta + u_i, u_i \sim N(0, \sigma^2) \quad (2)$$

$$y_i = y_i^* \text{ if } y_i^* > 0 \quad (3)$$

$$y_i = 0 \text{ if } y_i^* \leq 0 \quad (4)$$

where y_i^* is the latent dependent variable (respondent's WTP amount), y_i is the observed dependent variable (respondent's WTP amount censored at zero), and x_i is the vector of independent variables. The variables included the respondent's climate change news sources, valued urban forest attributes, support for a cost increase to reduce carbon emissions, whether the respondent identified with being black, age, annual household income, percent tree canopy cover in the respondent's Census tract, and highest level of education. β is the vector of coefficients, and u_i is the error term, assumed to be independent, normally distributed. The correlations of the predictor variables, including income and urban tree cover (correlation was 0.05), were checked and collinearity was not found to be present.

An individual's unconditional expected WTP value, with censoring at zero (Greene, 2008), is represented as follows:

$$E(WTP) = \Phi\left(\frac{X_i\beta}{\sigma}\right) [X_i\beta + \sigma\lambda(\alpha)] \quad (5)$$

where Φ represents the normal density function, ϕ represents the normal density function, σ represents the standard deviation, and

$\lambda(\alpha)$ is the inverse Mills ratio, $\left[\frac{\phi\left(\frac{X_i\beta}{\sigma}\right)}{\Phi\left(\frac{X_i\beta}{\sigma}\right)}\right]$. The marginal effects (McDonald and Moffitt, 1980) of a change in any covariate on $E(WTP)$ can be represented as:

$$\frac{\partial E(WTP_i|X_i)}{\partial X_i} = \beta\phi\left(\frac{X_i\beta}{\sigma}\right) \quad (6)$$

4. Data

Out of the 5500 surveys mailed, 1021 were returned with bad addresses and 4 opted out of the survey by mailing back empty questionnaires (as detailed in survey instructions). After accounting for declines and returned or undeliverable surveys, the revised survey sample was 4475 with 470 surveys completed and deemed usable for the study, yielding a response rate of 10.5 percent. Other recent studies using mail surveys yielded similar response rates with Thompson and Hansen (2012) at 15.9 percent, Hill et al. (2010) at 12 percent, and Rothlisberger et al. (2010) at 11 percent.

Based on the comparison of survey results to Census information, there were significant differences between the percentages of white and black population, percent of population with bachelor's degrees or higher, and median household income. Thus, black individuals, lower income households, and lower educated households were underrepresented in the sample. Lower education and lack of interest emerge consistently as characteristics of survey nonrespondents (Rogelberg and Luong, 1998).

Table 1
Survey Results Compared to 2010 U.S. Census Data, Atlanta.

	2010 Census	Raw Sample	Weighted Survey
Households	179,459.0	470.0	468.0
Average Household Size	2.2	2.1	n/a
Households with Individuals 65 years or older	17.8%	16.4%	n/a
Females	50.2%	47.9%	51.8%
White alone	38.4%	71.7%	39.8%
Black or African American alone	54.0%	22.2%	54.4%
Other (includes American Indian and Alaska Native alone, Asian, and Two or More Races)	5.3%	5.8%	5.8%
Hispanic or Latino, percent	5.2%	5.1%	6.2%
Bachelor's degree or higher	46.1%	76.4%	44.8%
Median household income	\$45,946.0	\$87,500.0	\$42,500.0

A total of 436 respondents out of 470 responded to gender, age, and race questions. Using this information, the weight was focused on the households. To better represent characteristics of households in Atlanta, the sample was weighted by U.S. Census 2010 data (US Census Bureau, 2010). Three weighting variables were used: (a) ethnicity (black, white, and other), (b) education (less than a bachelor's degree level of education versus bachelor's degree level of education and higher), and (c) gender. In the United States, education has been shown to be closely correlated with income (Gregorio and Lee, 2002). The combination of these three variables and their associated levels resulted in 12 cells (i.e., 3 levels of ethnicity * 2 levels of gender * 2 levels of education = 12). Weights were calculated using the formula: Weight = Population Percent/Sample Percent. This multivariate weighting strategy used to address nonresponse bias has been used in a previous study by Vaske and Donnelly (2007). This strategy has also been accepted by the U.S. Office of Management and Budget after a study was performed addressing nonresponse bias with the National Survey on Recreation and the Environment (Leeworthy et al., 2006). Percentages discussed henceforth are weighted, unless otherwise noted.³

Previous studies have shown that Fox News airs more stories that question the existence of human-caused climate change than other television news stations, which result in Americans being less certain that climate change is happening (Hmielowski et al., 2014; Feldman et al., 2012; Krosnick and MacInnis, 2010); whereas CNN and MSNBC is associated with a greater acceptance of climate change (Feldman et al., 2012). National Public Radio (NPR) has generally been considered by news audiences as a neutral news source (Pew Research Center, 2012). Leiserowitz et al. (2015) found that climate scientists were among the top trusted news information source for climate change, which would be captured in the newspapers/magazines/journals variable. Because of previous research, we condensed our news variables to Fox News, NPR, MSNBC/CNN, newspapers/magazines/journals, and all other news sources.

5. Results

The weighted sociodemographic characteristics from survey respondents were compared with Census data (Table 1). Because respondents who identified as being Hispanic/Latino may be of any race, they were included in the applicable race categories. Compared to Census data, the survey respondents overrepresented the white category and underrepresented the black category. The median income of participants fell in the \$75,000 to \$99,999 cat-

egory, with an average of \$98,048.⁴ The median income when weighted was \$42,500, not far from the 2010 Census median income of \$45,946. About 76.4 percent answered they had completed a university or college education, but the figure was 44.8 percent when weighted, which is comparable to the Census figure of 46.1 percent.

Most respondents believed that climate change is occurring (88.8 percent) and that its effects are overall negative (68.5 percent). The respondents were asked to rate their level of agreement with a number of statements about climate change (Fig. 2). Respondents agreed most strongly that they were concerned with the potential effects of climate change with 84 percent who selected “agree” or “strongly agree.” Most respondents, 68.2 percent, who selected “agree” or “strongly agree,” felt that climate change action should be taken. Respondents disagreed that human activity had no effect on climate change with 66.6 percent who selected “disagree” or “strongly disagree.” Many respondents felt that more research is needed on climate change with 53.3 percent of respondents who selected “agree” or “strongly agree.” There was moderate agreement that climate change would be lessened if fossil fuel use is reduced with 48.4 percent of respondents who selected “agree” or “strongly agree.”

When residents were asked about their valued attributes of urban forests, the attribute of mitigation or adaptation to climate change was low, placing 11th on a list of 14 attributes. However, respondents who selected climate change mitigation as an important urban forest attribute were more willing to pay for the proposed program. The top five valued urban forest attributes were cleaner air and water at 78.9 percent, wind control at 68.0 percent, heat reduction at 63.7 percent, aesthetic beauty at 62.8 percent, and wildlife habitat at 56.6 percent (Table 2). Respondents felt strongly that urban forests enhance the attractiveness of Atlanta with 92 percent of respondents who selected “agree” or “strongly agree” (Fig. 3). Respondents felt that adding more trees should generally be a priority with 75.6 percent who selected “agree” or “strongly agree.” Many felt that urban forests did not create safety risks with 55.1 percent of respondents selecting “disagree” or “strongly disagree.” Most supported increasing urban forests as part of Atlanta's climate change strategy with 65.1 percent of respondents who selected “very much” or “completely” in agreement.

Respondents were asked to select the news sources from which they received their climate change information and the results were: Fox News (19.5 percent), NPR (41.2 percent), MSNBC/CNN (31.9 percent), newspapers/magazines/journals (42.7 percent), and all other news sources (85.5 percent). The results also showed that some residents were interested in receiving assistance in identifying appropriate tree species to plant, receiving tree seedlings, and

³ There is the possibility that nonresponse bias is completely random. A sensitivity analysis was performed as recommended by Groves (2006). Unweighted WTP including protest bids was \$66.51 per household. Unweighted WTP excluding protest bids was \$76.07 per household. The weighted WTP estimates were lower, and therefore more conservative. Thus, the weighted WTP estimates were used.

⁴ Calculated by first taking interval midpoints for each category, multiplying the frequency of each category by the midpoints, and then finally applying the formula: Mean average = $\sum (\text{Frequency} * \text{Midpoint}) / \text{Total Frequency}$.

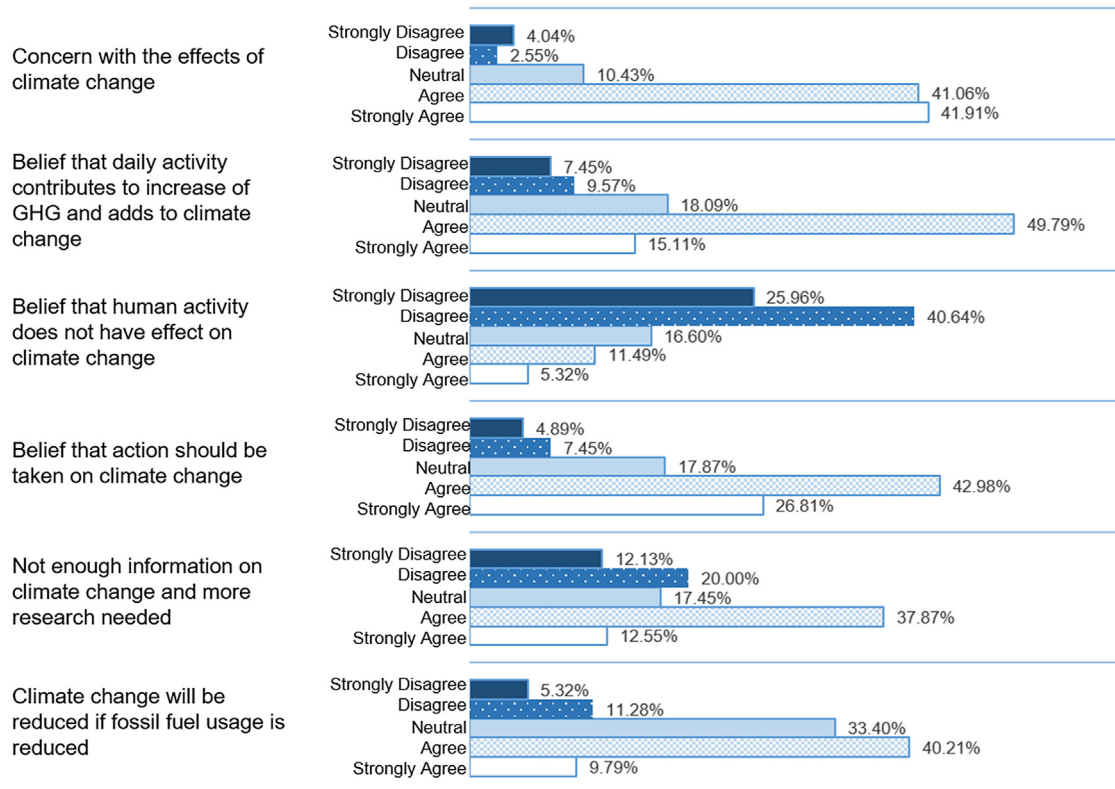


Fig. 2. Respondents' Level of Agreement with Climate Change Statements, Weighted (n = 468).

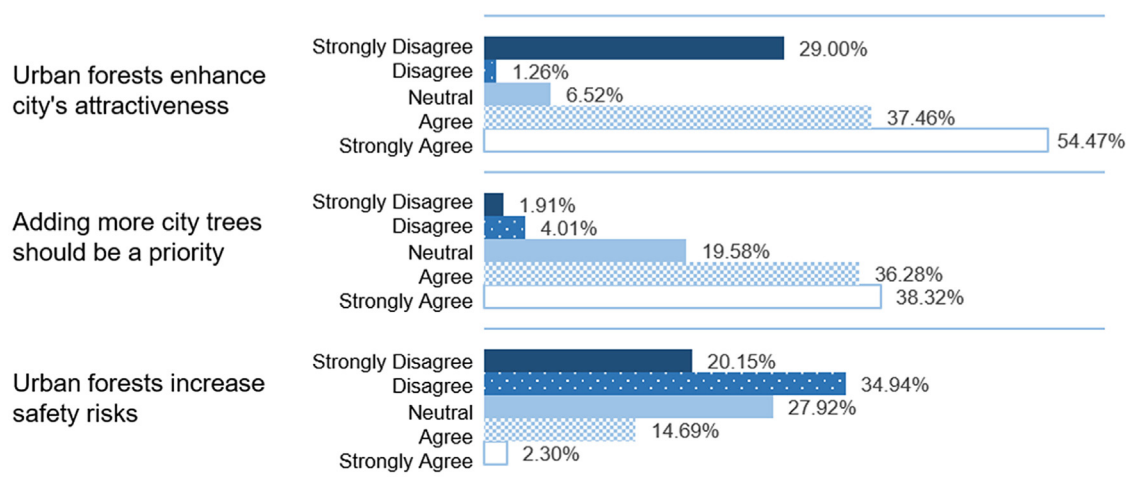


Fig. 3. Respondents' Level of Agreement with Urban Forest Statements, Weighted (n = 468).

a design plan for planting trees. A little more than half of these respondents were willing to pay a fee to offset these services.

WTP data were categorized into zeros and missing responses. There were 172 zero bidders, which was 36.6 percent of the entire sample. Based on follow up questions used in previous studies to separate legitimate bids from protest bids (Yu and Abler, 2010; Cho et al., 2008), 114 valid zeros and 58 protest bidders were determined. Because the decision process for these protest bidders are unknown, the Tobit model was estimated twice, first including the protest zeros and then excluding the protest zeros, to test if factors influencing the WTP were the same. The sample size was reduced to 382 when protest zeros were excluded.

WTP data collected also showed a high frequency of responses at \$50 and \$100 per household. The smallest positive WTP to increase urban forests in Atlanta was \$1 and the largest was \$1200, with an unconditional mean of \$76.70 (unweighted), which includes the \$0 responses. The highest bids, e.g., \$1000 (3 respondents) and \$1200 (1 respondent) were investigated for strategic bidding (Lienhoop and MacMillan, 2007; Mitchel and Carson, 1989). These respondents were found to have high household incomes and high levels of education; therefore, it was concluded that strategic bidding was unlikely for these relatively high bids.

The descriptive statistics of the variables run in the Tobit regression appear in Table 3. The significant coefficient estimates in the weighted model (including protest bids) returned were Fox

Table 2

Valued Attributes of Urban Forests (n = 470, weighted n = 468).

Attribute	Number	Weighted Percentage
Aesthetic beauty	366	62.78
Cleaner air or water	386	78.88
Heat reduction	330	63.70
Increased property value	208	35.62
Increased wildlife habitat	295	56.56
Mitigate or adapt to climate change	178	37.03
Noise and glare reduction	240	44.92
Recreation activities	217	36.40
Storm water control	266	47.48
Value for future generations	343	37.98
Wind control	191	68.03
None – no value	8	1.72
None – negative value	3	0.93
Other	23	7.08

News, climate change benefits from urban forests, cost increase to reduce carbon emissions in Atlanta, and percent urban tree canopy (Table 4). The results suggested that respondents who receive their climate change news from Fox News were less willing to pay for an urban forestry project as part of a climate change strategy, indicated by the negative and significant weighted coefficient estimate of the variable *news.fox*. The positive and significant coefficient estimate for *uf.reas7* (perceived urban forests benefit to climate change) indicated that residents who valued climate change benefits from urban forests were more willing to pay. Respondents who supported a decrease in carbon emissions in Atlanta were also more willing to pay for the urban forest project (*ce.bal*), which was expected. Age yielded a negative coefficient, which implied that the older the respondent, the less willing s/he was to pay for the project. House-

hold income yielded a positive and significant coefficient estimate, which suggested that respondents with a higher annual household income were more willing to pay for urban forests as a climate change mitigation method. The *tree* canopy variable yielded a significant and positive coefficient estimate, which suggested that the higher the tree canopy in a respondent's Census tract, the more willing the person was to pay for urban forests.

To estimate the WTP, we used Eq. (5). From the Tobit regression, we obtained $\Phi \approx 0.546$, $\phi \approx 0.396$, and $\sigma \approx 149.871$. The resulting estimated weighted household WTP to increase urban forests as a climate change mitigation method in Atlanta was \$68.78, excluding protest bids. According to Census data, there were 179,089 Atlanta households in 2010. If the WTP were simply aggregated using this information, the annual household WTP estimate for the city would be \$11,643,649.69 for each of the five years in total when excluding protest bids. The WTP excluding protest bids differed when including protest bids. Estimates were higher if protest bids were excluded (Table 5).

6. Discussion and conclusion

This study attempted to provide insight on the climate change values and attitudes of Atlanta residents by providing a tangible mechanism: expanding urban forests to mitigate climate change. Past research has found that tree cover in Atlanta has remained stable, but the distribution varied greatly over time (Merry et al., 2014). Due to the variance in tree cover distribution, temperatures at the city core have continued to increase at a higher pace than the surrounding areas, with the majority of the Atlanta land cover change having occurred outside of the city core (Stone et al., 2013).

Top valued urban forest attributes for this study in order of preference were cleaner air and water, heat reduction, aesthetic beauty, increased wildlife habitat, and storm water control, which is a lit-

Table 3

Descriptive Statistics for Variables in Tobit Regression.

Variable	Description	Number	Unweighted Mean	Weighted Mean
news.fox	Fox News	468	0.179	0.195
news.npr	National Public Radio (NPR)	468	0.414	0.412
news.paper	Newspapers, magazines, or journals	468	0.417	0.427
news.cnnmsnbc	CNN or MSNBC	468	0.322	0.319
news.other	All other news sources	468	0.849	0.855
uf.reas1	Aesthetic beauty	468	0.900	0.628
uf.reas2	Clean air/water	468	0.082	0.789
uf.reas3	Heat reduction	468	0.623	0.637
uf.reas4	Property value	468	0.341	0.356
uf.reas5	Wildlife habitat	468	0.589	0.566
uf.reas6	Noise/glare reduction	468	0.339	0.370
uf.reas7	Climate change	468	0.457	0.449
uf.reas8	Recreation	468	0.386	0.364
uf.reas9	Storm water	468	0.493	0.475
uf.reas10	Wind control	468	0.416	0.380
uf.reas11	Future value	468	0.640	0.680
ce.bal	Greenhouse gas tax until carbon neutral	468	2.718	2.592
black	Dummy Variable, 1 for black, 0 otherwise	112	0.239	0.531
age	Age of Respondent	461	49.672	50.271
income	Annual Household Income, 1 = less than \$15,000, 2 = \$15,000–\$34,999, 3 = \$35,000–\$49,999, 4 = \$50,000–\$74,999, 5 = \$75,000–\$99,999, 6 = \$100,000–\$149,999, 7 = \$150,000–\$199,999, 8 = \$200,000 or more	468	3.474	3.610
tree	Percent Tree Canopy Cover	468	0.377	0.393
educ.bach	Dummy Variable, 1 for bachelor's degree or higher, 0 otherwise	468	0.463	0.448

Table 4
Results for Weighted Tobit Regression of WTP for Increasing Urban Forests in Atlanta, Excluding Protest Zero Bids (n = 351).

Variables	Description	Weighted Coefficient Estimates	Std. Error	Partial Effect	Mean X
news_fox	Fox News	−71.279**	32.134	−25.393***	0.179
news_npr	National Public Radio	−29.581	22.330	−11.400	0.414
news_paper	Magazines, newspapers, or journals	−35.122	40.716	−13.834	0.417
news_cnnmsnbc	CNN or MSNBC	−36.046	24.203	−13.683	0.322
news_other	All other news sources	−20.316	25.845	−8.133	0.849
uf_reas1	Aesthetic beauty	−19.743	24.868	−7.774	0.648
uf_reas2	Clean air/water	−2.977	39.506	−1.163	0.817
uf_reas3	Heat reduction	−16.778	23.556	−6.583	0.623
uf_reas4	Property value	−4.528	26.282	−1.757	0.341
uf_reas5	Wildlife habitat	8.852	20.220	3.434	0.589
uf_reas6	Noise/glare reduction	11.214	23.931	4.386	0.339
uf_reas7	Climate Change as Reason for Urban Forests	52.298**	24.003	20.564**	0.457
uf_reas8	Recreation	20.336	26.503	7.988	0.386
uf_reas9	Storm water	24.481	23.650	9.536	0.493
uf_reas10	Wind control	−25.136	26.503	−9.703	0.416
uf_reas11	Future value	25.970	30.709	−10.256	0.640
ce_bal	Support of Cost Increase to Reduce Carbon Emissions	28.860***	8.933	11.231***	2.718
black	Black	−1.091	27.539	−0.425	0.527
age	Age of Respondent	−1.713***	0.713	−0.667***	49.672
income	Household Income	12.846**	6.013	4.999**	3.474
tree	Percent Tree Canopy Cover in Census Block	137.897*	74.571	53.661*	0.377
educ_bach	Education	16.851	25.081	6.575	0.463
_cons	Constant	−39.981	63.988		
/sigma	Standard Error of Regression	149.871***	20.052		
Pseudo R-squared: 0.0929					

Note: (*) 10% significance level; (**) 5% significance level; (***) 1% significance level.

Table 5
Summary of WTP Results.

Model	Household WTP	Aggregate WTP (all Atlanta households)	Aggregate WTP (10.5 percent Atlanta households)
Weighted Tobit, including protest bids	\$58.93	\$9,977,102.90	\$1,047,595.80
Weighted Tobit, excluding protest bids	\$68.78	\$11,643,649.69	\$1,222,583.22

tle different from previous studies. Foster (2010) found that the top five valued urban forest attributes in Tampa, Florida were aesthetic beauty, heat reduction, increased wildlife habitat, cleaner air or water, and storm water control were the top five attributes in order of preference. Lorenzo et al. (2000) found that the top five urban forest attributes for Mandeville, Louisiana residents were aesthetic beauty, heat reduction, increased wildlife habitat, mitigate or adapt to climate change, and increased property value. Difference in preferences are likely be due to differences in urban locations.

The WTP analysis showed that Atlanta households were willing to pay \$1.05 million to \$1.22 million per year, or \$5.24 to \$6.11 million over a five-year period, if conservative estimates are used, for a project budget to expand urban forests in Atlanta (Table 5). This study showed that residents who reside in higher tree canopy areas may be more willing to pay for additional urban forests because they more readily understand the benefits of the trees. The annual cost of maintenance for trees was estimated at \$100 for small trees, \$84 for medium trees and \$93 for large trees from the cost/benefit worksheet on the Urban Forestry Network website.⁵ Using the WTP totals and these estimates could amount to an additional 10,000 to 91,000 trees being maintained per year (including planting and maintenance costs).

Contrary to previous studies, educational attainment did not have a significant relationship with WTP, but income was found to be significant, which was consistent with previous studies (Zhu and

Zhang, 2008; Zhu and Zhang, 2006). Studies have found that higher income residents typically have higher demand for urban forests (Zhu and Zhang, 2008; Elmendorf et al., 2005). Implications of this result may suggest that those residing in more affluent communities, regardless of whether they themselves were affluent or not, were more willing to pay to increase and maintain urban forests as part of a climate change mitigation strategy because they already recognize the benefits of urban forests. Respondents may be either unaware of the role urban forests play in climate change or the other urban forest attributes were perceived as more valuable.

Media preferences for climate change information played a role in predicting the attitudes and preferences of climate change mitigation. Households who received their climate change news from Fox News were less likely to be willing to pay. These results suggested that media discourse may be a contributor to value judgments made by individuals when making decisions on issues related to climate change, which was similar to the results of Hmielowski et al. (2014), who found that conservative media use decreased trust in scientists which, in turn, decreased certainty that climate change was happening.

This study made every effort to increase participation rate. Incentives were not provided for participants due to funding constraints, although past research suggested that providing incentives, particularly with ethnic or minority populations can increase response rates (Gregory, 2008; Martin et al., 2001). However, the 470 observations acquired was large enough to make statistical estimates of the general population (Vaske, 2008; Dillman et al., 2009) and that a multivariate weighting technique was appropriate to address nonresponse issues (Leeworthy et al., 2006). Post sample weights were used to address nonresponse; however, there is no

⁵ Urban Forestry Network, <http://urbanforestrynetwork.org/costs/cost%20benefit.htm> [accessed on April, 13, 2015].

guaranteed solution to fully correct for nonresponse bias without conducting a formal study of nonrespondents, which was beyond the resources available for this study. Reasons for nonparticipation could include a lack of interest in urban forests or climate change issues. The large proportion of lower income and lower education black residents not represented in this survey could point to a low level of topic salience for Atlanta residents and a low level of political mobilization by climate change advocacy groups in the Atlanta region.

A high percentage of protest bids is common in open-ended and payment card formats (Cho et al., 2005; Bowker et al., 2003; Halstead et al., 1992). Protest bidders expressed concern over whether the city government would be able to carry out such a program, but there were generally positive comments for Trees Atlanta, a local nonprofit organization. This suggested that Atlanta and other cities should work closely with credible local nonprofit groups to increase community confidence. Involving the community in tree-planting projects can contribute to the sense of identity and increase leadership and expertise for residents (Austin and Kaplan, 2003). The protest bids could also imply that climate change awareness did not translate into a deep understanding or the perceived relationship between climate change and urban forests is weak. Further analysis of protest votes could serve to explicate residents' perceptions. The results of this study could help cities understand the subgroups of the population that might be more supportive of urban forestry and climate change projects and serve as a starting point to identify and resolve issues with unsupportive subgroups, particularly since urban expansion is expected to increase in the future (Nowak et al., 2005).

Examining residents' willingness-to-pay for urban forests provides insight for expanding urban forests and their implications to climate change policy. Implementation of such a project would require an assessment of public and private land available to be planted in additional trees. It would also require a city to offer residents technical assistance to plant trees on private land. Seminars or workshops to inform residents may be a useful tool to increase knowledge and understanding of urban forests in Atlanta.

Survey respondents may have elected to respond for altruistic reasons or because of strong agreement or disagreement over the topic of climate change or urban forests. Atlanta is the fifteenth most congested city in the United States for commuting workers with many of the workers driving from surrounding counties (Schrank et al., 2015). The majority of Atlanta lies in Fulton County and a small portion is within DeKalb County. The recent extensive growth of Atlanta has led to a disbursed settlement that includes the 11 surrounding counties within in the Atlanta Metro Area, as defined in the Atlanta Regional Commission and the jurisdiction of the Georgia Regional Transportation Authority. These counties experienced heavy deforestation and fragmentation from 1974 to 2005 (Miller, 2012). Future research studies should expand to the greater metropolitan Atlanta area to understand if suburban residents would be willing to pay for additional urban forests to reduce the amount of impervious suburban zones.

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